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CONTENTS

American Association for the Advancement of Science:—

The Contribution of Zoology to Human Welfare: DR. L. O. HOWARD 349

The Status of Physiology in America: DR. MAX WITHROW MORSE 354

Scientific Events:—

Aurora and Magnetic Storm of March 7–8 in England; Engineering Training School at the Stevens Institute; English Medical Students and Military Service; War Work of the U. S. Coast and Geodetic Survey 359

Scientific Notes and News 362

University and Educational News 363

Discussion and Correspondence:—

Evidence from Alaska of the Unity of the Pleistocene Glacial Period: DR. G. FREDERICK WRIGHT. *Drawings on Lantern Slides:* HORACE GUNTHORP. *Thin Sections for Bryozoan Slides:* CHARLES E. DECKER. *A National Floral Emblem:* ALBERT A. HANSEN. *Translations made Accessible:* LANCASTER D. BURLING 364

Scientific Books:—

Washington on Chemical Analyses of Igneous Rocks: PROFESSOR FRANK D. ADAMS... 368

Fossil Man at Vero, Florida: DR. OLIVER P. HAY 370

Special Articles:—

The Animal Census of Two City Lots: DR. GEORGE N. WOLCOTT 371

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THE CONTRIBUTION OF ZOOLOGY TO HUMAN WELFARE[1]

AT the Philadelphia meeting of the American Association for the Advancement of Science, Convocation Week, 1914–15, there was held, under the auspices of the American Society of Naturalists, a symposium entitled "The Value of Zoology to Humanity." I was, unfortunately, very busy with the affairs of the general association and was unable to attend this symposium. There were four papers presented. The first of these is printed in SCIENCE for March 5, 1915, and is entitled "The Cultural Value of Zoology." The address was given by Professor E. G. Conklin, of Princeton. It is a very readable address, full of interest, containing much of that delicate humor characteristic of Professor Conklin, and possibly rises nearly to the exact height demanded by the title. But it is not a zoological address, in spite of its title. It is broader, and comprehends all biology. It is divided into two headings: (1) "Contributions of Biology to Education"; (2) "Contributions of Biology to Civilization." Under the first heading he dwells upon the immense enthusiasm and intense concentration of the biologist in his work, touching upon the evil effects of over-specialization and referring to the few great leaders in biology who have become interpreters to the plain people—men like Huxley, Galton, Metchnikoff and Forel, who have applied the teachings of biology to social problems.

[1] Read before Section F (Zoology) of the American Association for the Advancement of Science in a Symposium upon "The Contributions of Zoology to Human Welfare," Pittsburgh, Pa., December 31, 1917.

He then dwells upon the powers of observation and imagination of the biologist, and the unique place which biology occupies among all the sciences in its cultivation of esthetic appreciation and broad sympathies. He admits that these elements of personal culture are not absolutely distinctive of the biologist, and that "some good men in other fields are biologists gone astray."

Among the contributions of biology to civilization, he refers to the conquest of nature by all of the sciences, and suggests as a topic for general debate at the San Francisco meeting of the association, "Who built the Panama Canal?" feeling sure that biology would be able to show that it deserved "a large share of the credit." Without entering into detail, he states that, while biology is not generally considered the equal of physics, chemistry or engineering in its contribution to civilization, agriculture, animal breeding, bacteriology, experimental medicine, pathology, parasitology, physiology, sanitation, are all based on biological research.

It is the summary way in which Professor Conklin dismisses this aspect which, I think, weakens the effect of his address, for he goes on in his final consideration to the statement that "the highest service of science [mind you, science in general] to culture has been in the emancipation of the mind, in freeing men from the bondage of superstition and ignorance, in helping man to know himself." As a generalization this is fine, and he goes on to state that the doctrine of evolution which has revolutionized all our thinking regarding man and nature is the greatest contribution of biology to intellectual emancipation. His concluding paragraph is:

> Biology has changed our whole point of view as to nature and man, and has thus contributed more than any other science to the emancipation of mankind.

Another of these four papers was read by Professor G. H. Parker, of Harvard University, and was entitled "The Value of Zoology to Humanity: The Eugenics Movement as a Public Service." Here again we have an extremely interesting and important article, from which we may quote the conclusion only:

> To conclude, eugenics in the service of society is, in my opinion, entirely justified in demanding the sterilization by humane methods of those defectives who are in the nature of public wards, and this practise may be extended as experience dictates. Eugenics in its relation to propagating the best in the community has a fundamental position in that it is concerned through the elimination of the extremely unfit with the delivery of a reasonably sound stock for cultivation, but it is only secondarily connected with the final production of efficient members of society whose real effectiveness is often more a matter of social inheritance than it is of organic inheritance.

I consider Dr. Parker's address as a very valuable one, but, while showing what animal breeding has done, which may in a way be construed as relating to "the value of zoology to humanity," he uses this only as an indication as to what might be done with the human species; and, important as his address is, it is not directed specifically to the point at issue—the value of zoology to humanity.

The third of these addresses was by Dr. C. B. Davenport and was entitled "The Value of Zoology to Humanity: the Value of Scientific Genealogy." Here again we have a very important paper, written in Dr. Davenport's admirable manner. His argument in a broad way applies to the general field of biology, including botany, zoology and anthropology, and in a specific way to the human species. He refers to the complicated work of the animal breeders, and follows it with the statement,

> And yet this precious human kind of ours, whose progress is so fatal to the world, goes its blind way, like any jellyfish, mates almost at random and

then, after two or three generations, has lost all knowledge of the matings that have gone before. Of course, the race has got along, somehow, just as the lower animals get along; although we have been burdened with an intelligence sufficient to lead us to interference with the operation of pure instinct but not sufficient always to interfere wisely.

He instances especially, as indicating that the nature of the mating influences the progeny, the study of half fraternities, and mentions especially the case of a man born in 1668, a graduate of Harvard, whose wife was the sister of the first rector of Yale College, who entered the ministry and preached in southeastern Connecticut. His first wife was apparently a quiet, steady, religious woman of no apparent wealth or culture. Her children were farmers, and received no special education. His second wife belonged to a wealthy New York family, of high social standing and culture, and the children by this wife were educated at Yale College and became prominent in the affairs of the nation. The thought that occurs to almost any one in studying this case is that the wealth acquired by the second marriage enabled the superior education of the children which it produced, and that obviously education and environment brought about a very considerable contrast between the children of the two wives.

The whole paper, however, is a sound and striking argument showing the value of scientific human genealogy, a proposition, however, which most of us are ready to accept without any extended argument. The paper as a whole touches upon a single aspect of the main subject of the symposium, and this aspect in itself has only been thought of as zoological of late.

The final contribution to the symposium was on the value of museums, by Dr. Henry Fairfield Osborn. This too is a rather self-evident proposition. The address has not been published, but it is certain that the zoological work of the museums was more than competently handled. Dr. Osborn, as every one knows, entirely aside from his eminent standing as a paleontologist, is an expert in museum management, and has published many papers on the subject.

The symposium of 1914–15, as a whole, as pointing out in a comprehensive way the value of zoology to humanity, is very disappointing and by no means does justice to the subject. In fact, it touches on only four aspects of the topic and these by no means of the first importance; and, moreover, in one of the papers it confuses zoology with general biology if not scientific thought as a whole.

No one denies the abilities of the speakers, who were, and are in fact, four of the most prominent among the American workers in zoology, and any one of them, if given the whole field, would doubtless have made a magnificent showing. To each, however, was assigned a subtitle, and thus the value of zoology to humanity received a most unsatisfactory treatment. One prominent worker in zoology as applied to medicine, I am told, left the meeting undecided whether to relieve himself by jeers or by tears, and it was at his suggestion that the present supplementary symposium has been arranged. Mind you, this one will not be sufficient unto itself, since each speaker is assigned one general topic, but if it properly supplements the other it ought to outweigh it in proportion of anywhere from ten to one hundred to one.

And now let us see what those zoologists who study insects have done and are doing for the welfare of humanity. The class Insecta includes a host of species which are most keenly competing with the human species in the struggle for existence. The

insect type is one of the most persistent types in nature. Having its origin in Carboniferous or perhaps Silurian times, it has persisted and flourished, adapting itself to almost all conceivable conditions until at the present time it is, among all the types of living things, the chief competitor of the recently evolved human type for the control of the earth.

Man labors for months to produce a food crop—he must share it with many species of insects. He builds himself a house with infinite toil—it must harbor insects as well. He makes garments for himself—without great care on his part they are eaten by insects. His harvested food is destroyed by them; his blood is sucked by them; he sickens and dies from a multiplication of disease germs which they have introduced by their bites or with which they have contaminated his food, and after his death they consume his body.

Let us begin with food crops. Always a vital subject, this has become one of the most intense interest under the present world conditions. In time of peace and before the intensified effort was begun to feed not only ourselves but a large part of the rest of the people of the world, the damage by insects to the food products of the United States was estimated at approximately $1,300,000,000 per year, or roughly, about ten per cent. of the whole. This estimate, as expressed in monetary terms, is open to criticism for the obvious reason that a fall in production is followed by an increase in price. But the loss may equally be estimated in terms of human food and consequently of human vitality. A loss of ten per cent. of the possible food, and not considering the question of waste, means strictly that a given number of people must live on a ration of ninety per cent. of the possible; not necessarily that ten per cent. of the people must die of starvation.

Accepting the monetary terms as the most convenient, let us see what the zoologists have done in this direction for the "welfare of humanity."

In 1907 the question arose (it was propounded by Mr. Littlefield, at that time chairman of the Committee of the House of Representatives on Expenditures in the Department of Agriculture) as to how much the work of the Department of Agriculture saves to the country annually. Secretary Wilson passed this question on to the chiefs of the bureaus. The Chief of the Bureau of Entomology passed it on to the heads of different sections of the work of the bureau. When the entomological estimates were handed in they summed up the total of $500,000,000, and they appeared to the Chief of the Bureau to be incredibly large, and the total was scaled down to less than one half. When the resulting estimate from the chief was submitted to the Secretary of Agriculture it appeared to Mr. Wilson to be still very much too large (possibly in comparison with the saving resulting from the work of the rest of the Department of Agriculture), and he in turn scaled it down to more than one half of this half. When the totals came to Mr. Littlefield in his committee room, the estimates of the whole department appeared to him to be very much too great, and he scaled down both individual items and totals, including the estimate from the Bureau of Entomology. The result as published in Mr. Littlefield's report gives the annual saving from the labors of the Bureau of Entomology (which is only one of the organizations of zoologists at work in this direction) as $22,750,000. But who shall say whether the original estimates of the chiefs of sections in the bureau were not more nearly correct than this? In fact, it seems more likely that the entomologists have saved to this country much more

nearly the original estimate of the experts than the final estimate of the Congressional committee. I have shown that our estimate of the loss is based at about ten per cent. of the possible production of our crops taken as a whole. Who is in position to say that it would not be twenty per cent. were it not for the general use of remedies already found and continually being improved by the students of insects?—in which case the saving would be more than a billion of dollars a year to the United States alone. And how many people can be fed with a billion dollars a year, and what work could they do!

This is perhaps the high spot in our treatment of this subject. It must be remembered that the work which brings about these results is done for the most part by trained scientific men. To find a remedy for an injurious insect presupposes a long training followed by the closest observation. It includes a broad knowledge of the structure, of the classification, of the life histories, of the behaviors of the species involved, of laboratory methods and technique, and that inspired insight which is a part of the nature of the best men of science. Workers in pure science are inclined to look down on workers in applied science, but nowhere have the qualities of the research man come into closer play than they have in the investigations in economic entomology along the line of crop enemies; and the same may be said of all of the other work in applied zoology.

We are accustomed to think of the insect enemies of growing crops as those of main importance, but after the crops are harvested and food products are stored they are attacked by a host of species. In the present crisis the problem of preserving food stuffs for considerable periods after harvest from the attacks of insects has become of the utmost importance. Long before the Russian revolution a conference of all of the entomologists of Russia was held to consider this very question. During the present month one of the most experienced entomologists of England, Professor H. Maxwell-Lefroy, passed through this country on his way out to Australia to look into the condition of Australian wheat ready for export to the United States, for the purpose of preventing damage by weevils and other insects injurious to stored grain. Much depends on the success of this man. Conditions are readily conceivable under which this great store of grain, which means so much to this country at the present time, may be utterly destroyed—an almost catastrophic prospect—and any reduction in its amount will upset the close calculations which concern themselves with the vitally important grain trade of to-day. The United States has sent milled grain in great quantities to England. To avoid the long sea haul, Australian grain will go to the port of San Francisco and will be milled in this country to replace the supply already sent to the East.

And then comes the enormous problem of medical zoology, in which the entomologist has a most important interest. Other aspects of this question will be treated by another speaker, and it is true that most of the important discoveries concerning the carriage of disease by insects have been made by medical men and not by entomologists. But even in these cases, the discovery once made, the entomologist, with his training in methods of investigating the life history and habits of insects, plays the important part in the investigation of every point in the life history, habits and behavior of the insect carrier and in the perfection of the methods for its destruction. I have even gone so far as to state, what to me seems a self-evident fact, that the prevention of insect-borne diseases is a matter

for the economic entomologist and not for the medical man; or, at the very least, for the individual who does not yet exist, namely, the medical man trained as an entomologist. It is true that the practise of the results obtained by the research of medical entomologists may eventually be placed in the hands of men of lesser training or of men who possess other sanitary qualifications, such as the sanitary engineers, but the entomologist is a vital link in the chain. Entomologists, as such, will receive more and more consideration from sanitarians, especially in Army circles, as is indicated by the fact that, from a zero beginning in 1914, at the present time with each sanitary unit of seventy in the expeditionary forces of Great Britain there are two trained entomologists.

I might easily have prepared a paper of ten times the length of this and adding to its effectiveness, but other speakers are waiting to add their expert testimony to the enormous "value of zoology to the welfare of humanity." L. O. HOWARD

THE STATUS OF PHYSIOLOGY IN AMERICA

IN a recent issue of our most widely read medical journal[1] there is presented an arraignment of modern biology which can not be passed by without serious consideration. This is so not because the writer of the review has presented the case exhaustively, or even fairly, but because the statements are commonly made and therefore deserve examination.

Modern biology is a composite, its several components derived from the following sources:

1. Traditional natural history of pre-Agassiz times.
2. The laboratory period of Agassiz.
3. The morphological period of Darwinian corroboration and consequences of the "Origin of Species."

[1] *Journal of the American Medical Association*, September 29, 1917, column Book Notices.

4. The newer physiological aspects, introduced by the experimental school.
5. The dictations of the professional schools—medical, agricultural, etc.

Of the two great divisions, botany and zoology, the former has exhibited a more catholicity of view. Unlike zoology, the curricula of departments of plant study offer a more complete survey of the essential aspects of the subject. Both the functional as well as the morphological divisions are presented, for a typical curriculum of botany includes not only the morphological studies, similar to those of the department of zoology, but an integrated division of plant physiology, part and parcel of the department. To find an equivalent to this state of affairs in zoology, one must confine himself to a comparatively few of our institutions of learning. A typical case is presented by Princeton, and the result, indicated by the character of investigations produced from the department of biology of that university, has apparently justified the incorporation of functional study into the department. However, such instances are the exception rather than the rule and the number of institutions which embody this idea increase at a very low ratio from year to year.

The arrangement which is practised in many institutions is that which is exemplified by Columbia University. The department of zoology includes a professor of experimental biology and the courses presented by him are physiological, to be sure; yet these courses are advanced and are specialized for certain research work with which the department has been identified since 1904. For the undergraduate, nothing is available as far as a survey of functional zoology is concerned; that work is relegated to the medical school. In this respect, as we have said before, Columbia is typical inasmuch as the zoologist *leaves to the medical school the functional aspects of his science.*

Owing to the growing potency of the fifth factor mentioned above in our enumeration of the various components of modern biology, this condition of affairs is growing *pari passu* At California, where traditionally the depart-

ment of physiology was general in its bearing, to-day we find it incorporated under the medical components of the university. Now there is nothing more evident to one who takes the trouble to investigate for himself than that the medical school is distinctly a vocational element, participating seriously in the modern "Zweckmässigkeit" or teleology which is insinuating itself more and more into our social fabric. In many ways, this is as it should be. Medicine, besides being a science, or composite of all the sciences as far as they can be made to bear upon human welfare, is likewise an art; and the practical aspects hold sway more tenaciously in the country at large than in some of our eastern medical institutions, such as Johns Hopkins, so that one must not judge of the spirit of medicine from a few chosen, advanced institutions such as the one we have mentioned. In fact, the pure science leanings of Johns Hopkins and other medical schools have been utilized in certain quarters as destructive criticisms of these institutions in their rôle as purveyers of medical training. More and more the intensely practical. "fruitgathering" functions of the medical school are being emphasized.

Now all this has direct bearing upon the matter in hand. We have seen that zoology, typically, leaves to the medical school the functional side of its work. We have seen, too, that the typical aspect of the medical school is teleological, the end being the production of practical physicians. Consequently, the physiology of the medical school is attuned to the obtaining of results bearing directly upon human material. Muscle-nerve preparations are paramount upon the one side, metabolism studies upon the other. The zoological, that is the comparative, or general aspects of the living thing are approached casually. In the nature of the case, this must be so; *the problems of the medical physiologist are succinct and different from those of the zoologist.* It is to be considered an imposition for this condition of affairs to exist, for the medical physiologist gains little from his associations with the student from the department of zoology, whereas the zoologist gains materially from the association, yet so crowded and interdigitated are the various activities of the medical school that, save in a few cases, it is stealing the time from the professor and assistants to handle the zoological physiologists. Of far greater importance, however, from the side of efficiency is this: The zoological student gains the impression that the fundaments of the study of living functions can be gained from the presentations of the medical physiologist who deals with human and mammalian material. In common parlance, he is not getting his money's worth.

Physiology, then, falls into the following distinct groups:

1. General physiology, found in such isolated examples as may be culled by a perusal of the catalogs of our universities and colleges.
2. Botanical physiology, a part of departments of botany.
3. Zoological physiology, rarely presented as such.
4. Applied physiology:
   (*a*) Medical physiology.
   (*b*) Agricultural physiology, etc.

The statement is frequently made by applied physiologists that they are presenting the subject in a broad way and making what is essentially "general or biological physiology" out of their work. Nothing is more evident from such statements than that there is extant a distinct failure to grasp what is meant by the terms general or biological physiology. Let us take an example: One of the most successful teachers and men of research in physiology to-day presents an opening course in physiology. The content of the course consists of the familiar experiments in muscle-nerve physiology, as a background; why is not the muscle-nerve preparation sufficient to demonstrate the essentials of contraction, irritability, etc., which are the fundamental characteristics of protoplasm everywhere? Is there anything more "general" or more "biological"? The answer may be given in various ways, but scarcely save in the positive. There are many ways of presenting more fundamental factors, for in the first place, while

contraction is indeed one of the fundamental properties of living beings, you have selected in the muscle-nerve preparation a highly specialized mechanism which may have nothing essentially to do with contraction as it occurs in more undifferentiated protoplasm; the fact that this same professor presents, in connection with the muscle-nerve preparation, the theories of construction of cross-striated muscle fibers is enough to cause one to pause in stating that he is dealing with a case of "fundamentals." As for the nerve, we have again a highly specialized organ for the transmission of impulses, which bears many differentiations, totally unlike what exists in the lower forms where transmission of stimuli proceeds. For the medical student, for whom these courses are designed, nothing could be better and the success which this man obtains with his methods in inculcating the knowledge which should be a part of all medical training is indicative of the fact that he is on the right track.

However, for the biological student, the course is inadequate. There is a wealth of material which can be presented in actual laboratory work concerning the fundamentals of protoplasm in general and of irritability and contractility in particular. What is needed is the simple recognition, born of actual experience, that such possibilities exist. They are appreciated in various quarters and the writer has found them recognized in even a medical school within the limits of the city of Boston, where they are not alone appreciated, but actually incorporated into the medical curriculum, in a small way, to be sure, but nevertheless therein.

It is not within the purport of an article of this kind to attempt to outline the presentation of general, or biological physiology. It may be sufficient to say, however, that were the catholicity of view of the average botanist equally well developed in the students of zoology, there would be no demand, as seems actually to exist, for an outline of a course in general or, specifically, zoological physiology. It is not biologists in the strict sense of the word who need the education, but zoologists. The difficulty centering about this one group of scientists demands elucidation; why is it that the average student of zoology is less familiar with function than the student of botany?

The answer to this question must not be that the departments of botany, as we have said before, present functional studies, while the departments of zoology do not; that is not a reason. *The adequate reason lies in the point of view.* For the plant student, there is no line of demarcation between form and function. The structure of the leaf is taken as a matter of course in terms of transpiration and of photosynthesis; one is not complete without the other. In elementary botany, these functional considerations are presented. What course of elementary zoology, even of the college grades, teaches the student the rudiments of the most important of all the properties of organisms, namely, oxidation? The minutiae of the nervous system of the cray fish are followed, yet the simple fact which we have just mentioned must be delegated to another department for presentation, that is, to the physiologist.

Morphology has been adhered to in a large manner on account of its supposed superior pedagogical value. Here are things succinct and things one may feel and handle.

From the tangible to the intangible in the perfect method. For reasons such as these, morphological aspects have held the center of the stage. Additional reasons have been of historical nature. The science of biology is still concerned with the method of evolution; witness the "fashion" of genetics, so all-absorbing that the subject dominates the cementing society of biological societies—the naturalists, together with an organ, one of the first of its kind in this country, namely, *The American Naturalist*. Now genetics *can* apply and do apply, as has been shown abundantly, to function but, for class presentation, form is much easier. Following the enunciation of the so-called Darwinian Theory, came a long line of verifiers and exemplifiers, who piled up the mass of data which has been systematized into our modern conception of

how evolution works. Function played a minor rôle in these classic studies, comparative anatomy, comparative embryology, comparative paleozoology and paleo-botany—all concerned with form, holding the fort. Hence, it is quite natural that these subdivisions of biology should persist with a lion's share for a time. In fact the generation of comparative anatomists, comparative embryologists and other morphological students is still with us. When we consider that the so-called "experimentalist" school, arising with Roux, Morgan, Loeb and others, took its inception only somewhat over a score of years ago, and that this school has been the first to direct the attention of zoologists to fields other than those cultivated by the verifiers of Darwin, we should not wonder that the fundamental aspect of biology, as far as teaching is concerned, which changes slowly, is principally morphological.

Now it is an interesting suggestion that although the biologists following Darwin were distinctly students of form, the founder of the theory which bears his name, along with his immediate associates, such as his "Bull-dog, Huxley," were really more interested in function than in form. Darwin's studies in climbing plants, in mould formation and in other things which may be called "dynamic," were of the spirit of the physiologist; he was interested in the manner in which the things worked, rather than in the varieties of form. Huxley for his part lamented that his career had not carried him closer to physiology.

We have seen how morphological aspects dominated and still dominate biology, especially zoology, even in the face of the early appreciation of things dynamic by the men whose researches gave inception to our sciences of biology. We have now to learn why physiology has been so slow to become recognized by the zoologists.

Mammalian physiology has outstripped all other functional studies. The medical school has persisted as a continuum from the times of the Greeks. Moreover, we should recognize why it has existed as a continuum; its relation to the art of medicine has insured this. Given a subject which has intimate bearing upon not alone the welfare of the human individual, but upon his very life, we may well suppose that it will develop faster and receive more prompt attention than a subject which, although perhaps bearing likewise upon the welfare of man, yet does not do so directly. It is natural then that the medical physiologists should have the lion's share of function. Medicine, again, is intensely eclectic, hunting and prying into the uttermost corners of human experience for things which it may take to itself and make a part of its own fabric. Consequently, we have been deluded with the apparent catholicity of human physiology and have been resting securely in the belief that it would take care of all our functional problems, be they of human reference or more general. It is true that the human physiologists have contributed largely to all that is worth while in functional studies. It is likewise true that they have failed to pursue the enigma beyond their own field save in isolated cases. They have always been interested in the cell studies of the biologist, but their contributions have been meager. We have instances, such as the classic researches of Fr. Miescher upon the cells of pus formation, out of which came our modern conception of the construction of nucleic acid at the hands of Jones and P. A. Levine; the studies of Claude Bernard upon oxidation of sugars; the fundamental studies of energetics (or thermodynamics) of Rubner, Atwater, Benedict and others; yet these studies are but instances and emphasize the paucity of contributions of medical physiologists to the fundamental problems of the cell, which, if we agree with the great pathologist, Rudolf Virchow, represents the *terminus ad quem* of all biological work, be it "biological," botanical, zoological, medical, or what-not.

The fact remains, then, that if the zoologist is to round out his science, making it equivalent for animals what botany is for plants, he can not expect the medical physiologist to take care of his problems in animal function. Comparative physiology, which has received a strong impetus in the "Handbuch" of Winterstein and in that of Jordan, will never

thrive in the medical school; there is no place for it and the tendency in the modern medical curriculum is to eliminate rather than to add to the already over-crowded subject list. Moreover, general physiology will find no place, for the aspect of functional study is from the top downward, from man towards the lower groups; the cell will continue to be treated as an interesting organ, even as the liver is considered, but its study will progress in the medical laboratories only so far as the problems are of medical importance of a more immediate nature.

What, then, is to become of general, or what we may term zoological, physiology, granting that botanical physiology is in good hands?

There are no agencies, save a very few, whereby a prospective student of zoological physiology can gain the training necessary for his work. We must eliminate the medical courses in physiology and in physiological chemistry. Zoology must recognize the importance of taking care of its own ground and develop means of deriving a line of zoological physiologists. It must cease to permit men like our Gortners, McClendons, Mathewses, Lyons and others to be taken by the medical and other professional schools from biology into lines where their promises as students of fundamentals cease. Unless this is done, the considerate criticisms, such as the one we have referred to at the beginning of the present communication, that modern biology is in a parlous way; that it is unproductive and dealing with blue ethereal theories, and that its face, which should be directed as that of Janus, before and backward, is cast towards the old, rather than the new.

What the agencies must be which will be capable of bringing biology into line with its sister science, is a matter of lengthy discussion. The conditions are ripe for the production of a new order of work in dynamic biology, for the methods which have been worked out within recent years at the hands of Winterstein, Folin, Taschiro, Van Slyke, and others —the so-called "micro" methods applicable to small material afford an excellent place for beginning. Thus far the field is practically virgin. From the investigation side, then, we are ready. From the pedagogical aspect, as Mark Twain remarked about the weather, the discussion is plentiful, but nothing is done; zoologists want the development of more function, but they do not know what to do about it. Not trained themselves to carry classes in the subject, they are at a loss as to the method of procedure. There is but one way: Induce students entering biology to specialize as best they may to fill positions in dynamic biology and reward their efforts when they have been successful by instructorships and higher positions in their turn, in the departments of zoology. This programme has been actually put into force in one university. The great desideratum, however, is that the opportunities be more attractive than those offered by the medical departments of physiology and biochemistry.[2] Otherwise the same gravitations to these schools will take place as in the past. It is not a matter of salary altogether; it is mainly the creation of the appreciation for the work of these students. Again, it is undesirable that the studies should involve complicated apparatus, unfamiliar and expensive chemicals, etc. The simpler the more efficient will the work become. The plant physiological apparatus and methods of men such as Professor Genung are simple, inexpensive and readily appreciated by the student; the same should apply to general physiological methods and apparatus. It is not necessary to measure the hydrogen ion concentration in a class of this nature, especially where it is desirable to do so by complicated means, such as by a potentiometer for E.M.F. In this one instance, we have the extremely simple method, if it is necessary at all to present the matter to a class in functional zoology, of Marriott. Much better than any, is to eliminate the methods necessitating a fairly high degree of previous experience in physics and chemistry; enough will remain of fundamental importance which may be studied by the microscope, the test-tube and a few simple pieces of apparatus.

2 The writer is using the words of the late Professor F. P. Mall.

It is only by such means that biology is to maintain its place. The science has justified its existence, to be sure, in the unravelling of the complicated skein of genetics and sex. However, to eliminate criticism concerning the ability of zoologists to speak glibly of enzymes and catalyzers, or sex hormones and of chemical determiners, they should fortify themselves by a strong development of functional biology.

MAX WITHROW MORSE
6034 JACKSON PARK, WEST,
CHICAGO, ILL.

SCIENTIFIC EVENTS

AURORA AND MAGNETIC STORM OF MARCH 7-8 IN ENGLAND

THE auroral display is said to have attracted much attention, partly because it coincided with an air-raid upon London. The northern sky was lighted up with a crimson glow both before and during the raid, which started shortly after 11 P.M.; and the appearance was thought by an observer at Folkstone to be due to a distant fire. Sir Napier Shaw informs *Nature* that the Meteorological Office has received reports of aurora observations from Lerwick, Stornoway, Eskdalemuir, Donaghadee, Liverpool, Clacton and Southend, and forwarded the following account, by Dr. C. Chree, of the large magnetic disturbance recorded at the Kew Observatory between 9 P.M. on Thursday and 5 A.M. on the following morning. Mr. A. Lander has sent *Nature* photographic traces of movements in declination recorded at Canterbury during Thursday and Friday. Thursday's trace was remarkably even until shortly after 9 P.M., when the magnetic storm began. *Nature* remarks that it is possible that the disturbance was a repetition, after three 27-day intervals, of the large magnetic storm of December 16–17, 1917. There was a very considerable disturbance on January 12 at the end of the first 27-day interval, and a minor disturbance at the end of the intermediate interval in February.

Dr. Chree wrote: "A magnetic storm of no great duration, but very considerable amplitude, was recorded at Kew Observatory on the night, March 7–8, 1918. It began with a 'sudden commencement' at about 9h. 10m. P.M. on March 7. The largest movements occurred in the early morning of March 8, between midnight and 5 A.M., but smaller oscillations persisted for some time after the latter hour. The 'sudden commencement' was especially prominent in horizontal force (H); after a small, sudden fall there was a sharp rise of fully 60γ. The corresponding movements in declination (D) consisted of an oscillation of about 4′, the first movement being to the west. The range shown on the D trace was about 51′, the extreme easterly and westerly positions being reached at 2.20 A.M and 4.16 A.M. respectively on March 8. Between 1.11 A.M. and 2.20 A.M. of the same day there was a movement of 36′ to the east. The range on the H trace was about 240γ. A very rapid downward movement commenced about 2.3 A.M. on March 8, the fall during the next thirty minutes amounting to fully 185γ. After 5 A.M. on the same day there were only short-period oscillations in H of moderate size; but up to 10 A.M. the element remained depressed by fully 70γ as compared with its value on the previous day before the storm."

THE STEAM ENGINEERING TRAINING SCHOOL AT THE STEVENS INSTITUTE

THE Navy Department has designated the Stevens Institute of Technology, Hoboken, N. J., as the headquarters for the new United States Naval Steam Engineering School for the training of engineer officers for the U. S. Naval Auxiliary Reserve.

This school is the only one devoted to training engineer officers for *steam-engine service*, and is a branch of the large training school now located at Pelham Bay Park, New York. There is at Pelham, in addition to the school for general training of enlisted men, an Officers' Material School, Naval Auxiliary Reserve. Both the school at Pelham and the engineer officer school at Stevens are under the supervision of the Supervisor, Naval Auxiliary Reserve. The education of the engineer officers at Stevens is directed by Professor F. L. Pryor, of Stevens, who has been appointed

by the Navy Department, with the approval of President Humphreys, civilian director.

It is contemplated to make a five-month course for the training of an officer; one month to be devoted to military and ship duties training at Pelham; one month at Stevens to receive the preliminary requirements and duties of an engineer; one month in inspection and repair duties at local shipyards, machine shops and boiler shops; one month at sea in the engine room of different type boats; and one month subsequent training and examination at Stevens. It is expected to have about one hundred men in each of these divisions, or five hundred in all.

Three of the divisions will be quartered in barracks now in the course of construction on the college grounds at the corner of Sixth and Hudson Streets adjoining the Carnegie Laboratory of Engineering. The school divisions will attend classes in the lecture rooms of the college, and will take their meals at the college mess hall at Castle Stevens.

The instructors for the school, with the exception of the civilian director, will be regularly appointed commissioned officers of the United States Naval Auxiliary Reserve and will be selected particularly for their special work.

Quotas are furnished for this school by the various Naval Districts throughout the country as outlined by the Navy Department and are required to meet the following qualifications:

(*a*) Men of ability and officer material.
(*b*) Age 21 to 30 inclusive.
(*c*) Completed high-school course, and graduate of engineering course at a recognized technical school or an equivalent of the above.
(*d*) Must be regular Navy, N.N.V., or N.R.F. (any class) for general service.
(*e*) Physically qualified for line officer—standard of regular Navy.

ENGLISH MEDICAL STUDENTS AND MILITARY SERVICE

We learn from the *British Medical Journal* that the Minister of National Service has issued detailed directions with regard to the "protection from military service of medical students" now in civil life. These may be looked upon as the obverse of Army Council Instruction No. 153 of 1918, which governs the release of medical students from the ranks. (1) A medical student who on March 5, 1918, was a full-time student at a recognized medical school, and had at that date passed his professional examination in chemistry, physics and biology (or botany and zoology) for a medical degree or license is not (subject to paragraphs 5, 6, 7 and 8, below) to be called up, whatever his medical category or grade, so long as he remains a full-time medical student. (2) A medical student who on March 5, 1918, was a full-time student at a recognized medical school, and furnishes to the A.D.R. of his area a certificate from the dean, or corresponding official, of his medical school that he should be able to pass his first professional examination as above on or below July 31 next, is not to be called up before July 31 next, whatever his medical category or grade. If he passes that examination by July 31 next his case will thenceforward be treated as if covered by paragraph 1. If he does not pass by that date he will forthwith be called to the colors if otherwise available and required for service, unless he comes within the terms of paragraph 3. (3) A medical student (other than one whose case is covered, or is to be treated as if covered, by paragraph (1) who is or becomes a full-time student at a recognized medical school, and who is in Category B 2, B 3, C 2 or C 3, or is placed in Grade 3, is not (subject to paragraphs 4, 5, 6, 7 and 8) to be called up, so long as he remains a full-time student, without reference to the Director of National Service for the region. (4) A student protected under paragraph 3 who does not within twelve months of commencing his professional studies at a recognized medical school pass his first professional examination as above, will forthwith be called up if otherwise available and required for service. (5) A student protected under this instruction who fails to pass his professional examination in anatomy and physiology within thirty-six months of commencing his professional studies at a recognized medical school will similarly be called to the colors. (6) For protection

under this instruction a student must be enrolled in an O.T.C. and fulfil after enrolment the conditions of efficiency laid down for medical cadets. (7) Protected students delaying qualification unnecessarily, or otherwise not satisfactorily pursuing their studies, are to be referred to the director of National Service. (8) Protection will be withdrawn from a student who has been requested in writing by the Ministry of National Service to offer himself as a surgeon probationer, R.N., and has not within twenty-one days applied for enrolment as such. The remaining paragraphs of the instruction—which supersedes all previous instructions relating to the protection of medical students now in civil life—deal with formalities to be observed in the matter of certificates and of applications to tribunals in respect of medical students not hitherto called up but now no longer protected.

WAR WORK OF THE U. S. COAST AND GEODETIC SURVEY

UNDER the provisions of section 16 of an act approved May 22, 1917, and regulations established in accordance therewith, any of the vessels, equipment, stations or personnel of the survey may be transferred by the President in time of national emergency to the service and jurisdiction of the War Department or the Navy Department, and the same may be retransferred to the service and jurisdiction of the Department of Commerce by the President when the necessity for such service no longer exists.

By executive order dated September 24, 1917, the steamers *Surveyor, Isis* and *Bache,* their crews and 38 commissioned officers of the survey were transferred to the Navy Department, and 29 commissioned officers and 10 members of the office force were transferred to the War Department with military rank corresponding to their grade in the survey.

Some changes were made in the assignments of these officers; some were rejected for physical or other reasons and were returned to the survey by executive order and others were afterwards assigned in a similar manner. Some members of the crews of the vessels declined to enroll in the Naval Reserves and their places were filled by the Navy Department. Some employees of the office force and hands in field parties were drafted and others enlisted voluntarily in the Army or Navy. On March 1, 1918, 65 commissioned officers of the survey, 17 members of the office force, 5 ships' officers, 67 seamen and other employees of vessels and 21 hands from field parties, a total of 175 persons, were serving in the Navy or Army.

In conformity with the wishes of the Navy Department, after the beginning of the war all of the topographic, hydrographic and wire-drag work of the survey was directed so as to meet the most urgent military needs of the Navy Department. The work done comprises wire-drag surveys on the New England coast and coast of Florida; hydrographic surveys on the South Atlantic coast and Gulf of Mexico; the beginning of a survey of the Virgin Islands; the investigation of various special problems for the Navy Department; wire-drag surveys, current observations, and special work on the Pacific coast; and surveys in the Philippine Islands.

The work undertaken for the War Department by the field parties of the Coast and Geodetic Survey was intended to furnish points and elevations for the control of topographic surveys for military purposes. To expedite this work an allotment was made from the appropriation for the War Department to cover the expenses of the field parties employed. The chief of the division of geodesy was authorized to confer with officers of the Corps of Engineers, United States Army, and officials of the Department of the Interior in regard to the proper coordination of the various operations.

Extensive surveys were undertaken, including primary triangulation, primary traverse, precise leveling and determination of differences of longitude, and good progress has been made, and the results of previous surveys have been made available by copies or in published form as promptly as possible. From April, 1917, to January, 1918, 80 per cent. of the time of the office force of the geodetic division was devoted to war work. At the request of the War Department tables were computed for

the construction of maps on the Lambert projection. The Chart Division has done much work in the compilation of maps, furnishing copies of original sheets, and supplying information of various kinds required for military purposes.

SCIENTIFIC NOTES AND NEWS

THE University of California has conferred the degree of LL.D on Professor George F. Swain, of the Massachusetts Institute of Technology and Harvard University, who this year delivered the Hitchcock lectures at the University.

OXFORD UNIVERSITY has conferred the degree of D. Sc., on Professor W. C. M' Intosh, for many years professor of natural history in the University of St. Andrews.

THE Paris Academy of Sciences has elected M. Flahaut of Montpellier to take the place of the late M. Gosselet. He has been the correspondent of the academy for the section on botany since 1904.

SIR J. J. DOBBIE, British government chemist, has been elected a member of the Athenæum Club for eminence in science.

WE learn from *Nature* that an Entomological Society of Spain has lately been founded, with its center for the present at St. Saviour's College, Saragossa. Dr. Hermenegildo Gorría, of Barcelona, is the president for 1918, and the Rev. R. P. Longinos Navás, S.J., the secretary.

THE Bureau of Standards has announced the appointment of Samuel S. Wyer, a consulting engineer of Columbus, Ohio, and Mr. Willard F. Hine, chief gas engineer of the Public Service Commission of the First District, New York State, as consulting engineers on its staff.

DR. SAMUEL A. TUCKER, of Columbia University, Dr. H. R. Moody, of the College of the City of New York, and J. M. Moorehead, of Chicago, have been added to the personnel of the chemical section of the War Industries Board.

DR. JOHN LYON RICH, of the department of geology at the University of Illinois, has been commissioned a captain in the National Army. He is assigned to Washington, D. C., for service in the Intelligence branch of the army as a specialist in geography.

CAPTAIN R. G. HOSKINS, of Northwestern University Medical School, Captain L. A. Congden, Lieutenant F. A. Cajori and Lieutenant A. G. Hogan, have completed a month's study of army nutrition at Camp Zachary Taylor, Louisville, Ky. They comprise a "Nutritional Survey Party" from the office of the Surgeon General of the Army.

DR. W. A. CANNON, of the Department of Botanical Research of the Carnegie Institution, sailed in April to Australia and will be away from the United States about twelve months. He will visit certain of the more arid portions of West and South Australia where he will make field studies of the desert plants with especial reference to root habits.

WE learn from *The Journal of Industrial and Engineering Chemistry* that Dr. Yogoro Kato, professor at the Tokyo College of Technology and director of the Nakamura Chemical Research Institute in Tokyo, is visiting the United States for professional purposes and Mr. T. F. Chin, of Pekin, China, principal technical expert of the Chinese Ministry of War, is in this country with the Chinese mission to make purchases for the outfitting of an extensive chemical laboratory at Pekin for his government.

PROFESSOR T. L. HAECKER, of the University of Minnesota, who has been asked for several successive years to continue his experiments in animal nutrition, despite the fact that he has passed the usual age for retiring from service, will retire at the close of this college year, July 31, 1918, and provision will be made for completing the work upon which he is engaged and for tabulating the results.

DR. EUGENE R. KELLEY, Boston, has been appointed state commissioner of health to succeed Dr. Allan J. McLaughlin, who has been called back into the federal public health service.

DR. BUFORD JENNETTE JOHNSON, Ph.D. (Hopkins '16), has resigned her position as assist-

ant psychologist in the Laboratory of Social Hygiene, Bedford Hills, N. Y., and has accepted an appointment as research assistant in the Bureau of Educational Experiments, New York City.

DR. OLIVER W. H. MITCHELL has resigned as head of the city laboratories at Syracuse, N. Y., and is succeeded by Dr. Augustus J. Gigger, formerly bacteriologist for the Rhode Island State Department of Health.

THE firm of Waddell and Son, which has offices in Kansas City and New York City, has recently become incorporated. The new firm of Waddell and Son, Inc., includes, besides Dr. J. A. L. Waddell and N. Everett Waddell, their former assistant engineers, F. H. Frankland, Shortridge Hardesty, and L. C. Lashmet.

AT a recent meeting of the scientific staff of the Bureau of Biological Survey, U. S. Department of Agriculture, Dr. C. Hart Merriam, founder and former chief of the bureau, now consulting biologist, U. S. Department of Agriculture, and research associate on the Harriman Foundation, Smithsonian Institution, delivered an address on the "Origin and Early History of the Biological Survey."

PROFESSOR E. V. MCCOLLUM, of the Johns Hopkins University, on April 12 addressed the Chicago section of the American Chemical Society on "The Biological Analysis of Food."

A MEETING of the Botanical Society of Washington was held at the Cosmos Club, Washington, D. C. on April 2. The program was "The Grain Sorghums: The Botanical Grouping of Cultivated Varieties" (with lantern), by C. R. Ball; "The Shaw Aquatic Gardens" (with lantern), by F. V. Rand.

THE first "Silvanus Thompson Memorial Lecture," founded by the Röntgen Society, London, in memory of its first president, was delivered by Sir Ernest Rutherford on April 9.

THE annual meeting of the American Association of Museums will be held at Springfield, Mass., on May 20, 21 and 22.

THE Council of the Southern Society for Philosophy and Psychology has decided, on account of the general situation and of the number of members of the society who are engaged in various forms of national service, to abandon the annual meeting scheduled to be held at Peabody College, Nashville, this spring.

THE committee on botany of the National Research Council urges throughout the country to aid in securing data in reference to important crop diseases. In connection with what may be called the "barberry campaign," the following information is desired from as many regions as possible: (1) prevalence of barberry, (2) amount of infected barberry, (3) the neighboring grass flora, (4) amount of back rust on these grasses, (5) proximity of infected barberry and grasses to grain fields, (6) relative susceptibility of the different varieties of barberry (including *Mahonia*). Such information should be reported to Professor E. C. Stakman, University Farm, St. Paul, Minn., who will organize and distribute the data.

UNIVERSITY AND EDUCATIONAL NEWS

SEVERAL gifts and bequests were announced at the recent meeting of the corporation of Yale University. Mrs. James Wesley Cooper, of Hartford, has given $5,000 for the establishment of a publication fund in memory of her husband, who graduated from the college in 1865, and who was a member of the corporation for over thirty years. The widow of the late William A. Read, of New York, has made a memorial gift of $5,000 to assist the work of the Yale University Press. Two bequests have been received, one of $10,000 from the late Samuel J. Elder, '73, for the college, and one of $5,000 from the widow of Amory E. Rowland, '73 S., for the benefit of the Sheffield Scientific School.

IT is stated in *Nature* that an anonymous donor has given Oxford University £500 towards the fund for the endowment of the professorship of forestry, and that the University of Liverpool has recently received a gift of £2,000 from Mrs. and Miss Holt as a

contribution towards the cost of equipment of the new department of geology.

Harold Ernest Burtt has been appointed instructor in psychology at Harvard University.

The first incumbent of the newly founded chair of phthisiology at the University of Edinburgh is Sir Robert W. Philip, professor of clinical medicine, said to be the founder of the first antituberculosis dispensary.

DISCUSSION AND CORRESPONDENCE

EVIDENCE FROM ALASKA OF THE UNITY OF THE PLEISTOCENE GLACIAL PERIOD

To the Editor of Science: In an article entitled "Frozen Muck in the Klondike District, Yukon Territory, Canada," by J. B. Tyrrell, of the Canadian Survey, published in the *Transactions of the Royal Society of Canada,* Series III., 1917, Volume XI., pages 39–46, there is a remarkable collection of facts seeming to prove the unity and continuity of the Pleistocene Glacial Period. It is true that there was no extension of moving glacial ice over the Klondike region, but there is abundant evidence of a change of climatic conditions corresponding to that of the generally glaciated region of the continent. During the warmer climate of the Tertiary period the streams had built up extensive gravel deposits over the bottoms of many of the valleys. For a long period "the climate had been temperate, or at all events, not arctic, and large numbers of animals, such as bison, mammoth, elk, moose, horse, etc., had roamed over the country.

Suddenly, a new set of climatic conditions began to prevail. The Glacial Period began, and, while the vast sheets of ice which covered so large a portion of Canada during that Period never extended over the Klondike district, the cold undoubtedly became very intense, and as a consequence the ground became permanently frozen. With the freezing of the soil and of the underlying rock the processes of oxidation and disintegration of this rock were no longer possible, and the small tributary brooks which flowed over the frozen land into the main streams were no longer able to collect and wash down sand and gravel from it. The supply of sand and gravel having been thus cut off, it could no longer be distributed by the main streams over the alluvial flats as it had been distributed before, but nevertheless the sand and gravel flats themselves were not worn away by the streams as they would have been under normal conditions, for they were cemented into very resistant masses by a matrix of ice.

The sand and gravel so deposited and preserved on the alluvial flats is now overlain by a deposit of vegetable material locally known as "muck," which may have a thickness of ten, twenty, thirty, or even as much as one hundred feet. The plane of separation between the gravel and "muck" is usually sharp and well defined, though occasionally little layers of "muck" may be found included in the upper beds of the gravel. The general impression that a person gets from a study of the deposits, however, is that of a sudden change from gravel to "muck" (pp. 40, 41).

The significant thing is that this layer of muck whose formation started in a period of great cold in early glacial times, has gone on continuously and uninterruptedly accumulating down to the present time. The bones of the extinct animals above enumerated "are found in large numbers in the underlying gravels and in the bottom of the muck; but the climate would seem to have soon become too inhospitable for them, and their remains are very scarce in the higher portions of the muck and finally disappear from it altogether" (p. 45). Dr. Tyrrell believes "that a critical study of the plant remains from the various layers of the muck might furnish much interesting information as to the character and climate of that portion of the world, in which there has been a continuous formation of vegetable beds from the beginning of the Glacial Period down to the present" (p. 46). The bearing of all this upon the unity of the Pleistocene Glacial Period is too evident to need statement.

G. Frederick Wright

Oberlin,

DRAWINGS ON LANTERN SLIDES

It often occurs that one wishes to interpose diagrams or line drawings in a classroom lecture which is being illustrated by lantern slides, and one has to either forego the point entirely, or turn on the lights and use a chart, or put the necessary diagram or

drawing on the blackboard. In the first case the good teacher usually feels there is a failure of full elucidation on his part, while in the second case valuable time is lost, and a break is made in the lecture.

To overcome this difficulty the writer recently devised a simple plan to make line drawings and diagrams on glass slides to be used as regular lantern sides. Clean lantern slide covers are taken, and on them the objects desired are drawn with a "china marking pencil." One must not lift the pencil from the glass while drawing, or else use great care at the points where the pencil is lifted and the same line then continued. It is not necessary to make an absolutely black line, as any mark shows plainly. A few trials will show how sharp one's pencil should be for the best results. As wide a margin must be left as in making ordinary slides. If a mistake is made it can be erased with the finger or a blunt piece of wood. The mark does not rub out too easily, consequently the slides can be used without the further trouble of covering if they are to be of a temporary nature. However, they can be fixed permanently by finishing them in the usual way with a clean cover slip and bound with tape.

As the "china marking pencils" come in at least three colors, black, blue and red, and as their cost is slight (15 cents) and the whole process is simple and short, their use in this way is practicable and inexpensive. The pencils can be purchased at any good stationery store.

HORACE GUNTHORP
DEPARTMENT OF BOTANY,
UNIVERSITY OF MINNESOTA

A SUGGESTION FOR MAKING THIN SECTIONS FOR BRYOZOAN SLIDES

IN making thin sections for bryozoan slides it has been noted by the writer that many of them have a frosty, crystalline appearance when they have been ground to the desired thickness. In the process of grinding, numerous small particles of calcium carbonate are forced into the openings, obscuring the structure. As these fine particles have relatively large surface exposure, they will dissolve much more readily than the rest of the fossil when treated with dilute hydrochloric acid. It is best to let the acid act for only a very short time and then wash it off quickly, repeating the treatment several times, if necessary, until the structure stands out clearly.

CHARLES E. DECKER
UNIVERSITY OF OKLAHOMA

A NATIONAL FLORAL EMBLEM

Now that America is engaged in the grim business of war for the defense of democracy, we are tempted in our zeal to forget the things which are purely sentimental because of the pressing needs of the things practical.

But with the dreaded arrival of casualty lists, the great heart of the nation has been deeply stirred, the grief of America stands in yearning need of sentiment. And so sentiment—pure sentiment—sponsors the thought that the American people have a real need for a recognized national floral emblem.

When the cherished day of peace arrives, how shall we greet our boys returning from the front? With flowers? Of course, but how with flowers? Goldenrods? Daisies? Violets? Yes, with all of these, but national sentiments might well be crystallized on a single national symbolic flower.

The rose of old England, the Fleur-de-lis of France, the thistle of Scotland, the chrysanthemum of Japan; all these remind us that America at present does not possess a floral emblem to epitomize the things that are noble and good in the nation.

Why should not all that is best in the American nation be symbolized in a flower as a national emblem? The very mention of such a symbol should stir the depths of patriotism in the breast of every true American. Surely Germany is the loser by not having a well-known floral emblem. In Europe, America has been criticized for being too material—would not the adoption of a national flower be an esthetic step in the right direction?

If, then, it is agreed that America will be benefited by possessing a recognized national floral emblem, the selection of a suitable flower is a difficult task indeed. The flora of the country is so rich that the choice

is large and rendered especially difficult because many plants have each their host of earnest admirers and advocates. In the mind of the writer, a national flower should have certain definite characteristics which are here outlined.

First, it should not be a troublesome weed in any sense of the word. A plant symbolic of our national glory should not be one that pesters and troubles the farmer; such a plant would fall far short of attaining the desired object.

Second, the plant should be native and fairly common in all parts of the country.

Third, a national flower should be easy of cultivation in all regions of the United States.

Fourth, such a plant should possess grace and beauty of both flower and leaf.

One flower, in the opinion of the writer, stands out preeminently as meeting all of these conditions very closely; that flower is the wild columbine. Our native flora can boast of no more handsome or more graceful member than the beautiful columbine. It has much to commend itself strongly to the advocate of a national flower; its graceful, nodding flower and exquisite foliage presents an eloquent plea for the adoption of this gem of nature as a symbol of American ideals. The columbine is native, has never been known as a weed and exists in every state in the Union. In all altitudes may this plant be found, from the peaks of the Rocky Mountains and the highest altitudes of Virginia, to the low lands of the coast. The columbine is easy of cultivation in all parts of the country—thus it fulfils the conditions for the ideal national flower.

And as though to further fulfil requirements, the columbine flowers from April to July, being thus present in its greatest glory on the two occasions when a national floral emblem is most desired, Memorial Day and the Fourth of July.

Again, the American eagle holds a place in the affection of America not shared by any other fowl or beast. The generic part of the scientific name of columbine, *Aquilegia canadensis,* was applied by the great Linnæus because of the resemblance of the spurs of the flower to the talons of an eagle; the Latin name for eagle is *aquila.* The conspicuous floral color is red, one of the three national colors, although the throat of the flower is yellow. The Colorado columbine is blue.

The columbine possesses five petals, a character which could readily be considered as corresponding to the five points of the star on the national ensign. Furthermore, the five spurs of the petals are grouped around a central floral shaft, suggestive of the relation of the states to the central government. The leaves are usually thrice-divided, which could be considered commemorative of our three martyred presidents, Lincoln, Garfield and McKinley.

In order that any plant be universally recognized as the emblem of the nation, it is necessary that the national government take action and render the selection official. Many of the states have already adopted state flowers, and who will say that these states have not been benefited by their actions? One state, Colorado, has already selected the columbine as the floral emblem of the commonwealth. In the advent of action by the national government, a word of warning should be heeded. When a plant becomes well known, there is created a tendency toward the extinction of that species because of the abnormal demand thus created. When Bryant eulogized the fringed gentian, little did he realize that his words would cause such interest in the beautiful flower, that eager misguided collectors would practically exterminate the fringed gentian in many regions. The adoption of the Oregon grape as the state flower of Oregon resulted in its practical extermination in the vicinities of the large cities and the plant became increasingly scarce all over the state. The adoption of a national flower would create demands that should be met in a sane and reasonable manner, or the selection might spell the doom of the favored plant.

A native plant of undoubted grace and beauty, the columbine seems to be the natural selection as an emblem of all that is noble,

chivalric and good in the character of the nation; an inspiration to all true lovers of liberty and justice and a symbol of the ideals of the American people. Albert A. Hansen

Washington, D. C.

TRANSLATIONS MADE ACCESSIBLE

Scientific papers written in some of the foreign languages present few difficulties to large sections of the scientific public, but translations are frequently desirable and sometimes essential. In the past such needs have been supplied by individual initiative and certain papers have been translated time and again. In these days when waste is more nearly criminal than foolish, and cooperation so easy, it should be possible for a worker who needs a translation of a given paper to find out whether or not such a thing is already in existence among his fellow workers before he starts the job anew. And if it is he should be able to secure a copy by paying for the necessary typewriting.

In place of following the somewhat customary plan of making the suggestion and commending it to the attention of this or that organization, the writer has started the compilation of a card catalogue showing the location of manuscript and published translations of books or papers on geology and paleontology and is willing to undertake the expansion of this catalogue to include all translations of papers in these sciences. To do this will require the cooperation of all persons or institutions possessing manuscript translations.

In return the writer will be glad to answer all inquiries regarding existing translations of specific books or papers and will furnish the names of persons or institutions willing to furnish copies of translations in their possession. He can start this at once, and already has records of nearly a hundred, though the value of the service will increase with the addition of new lists of available translations.

The writer realizes that these translations will not maintain a single standard, but he is certain that with few exceptions they will be valuable, and hopes to have the cooperation of his colleagues in making them all available.

Lack of time and the present-day need of hewing to a line necessarily limit this catalogue to papers on geology and paleontology, but the writer is ready and willing to turn over his data to any organization wishing to adopt the scheme in its entirety.

The working of the scheme is perhaps best illustrated by the following reply postal card, which has already been forwarded to the members of the geological and paleontological societies and will be sent to any one else on request:

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This scheme of exchanging translations of papers in geology and paleontology is described in Science for April 12, 1918. It is available to all and depends for its success upon your cooperation. Lancaster D. Burling

Geological Survey,
Ottawa, Canada

SCIENTIFIC BOOKS

Chemical Analyses of Igneous Rocks. Published from 1884 to 1913 inclusive. With a critical discussion of the character and use of analyses. By Henry Stephens Washington. U. S. Geological Survey, Professional Paper 99, Washington, 1917.

The Quantitative Classification of igneous rocks is one of the many very important contributions which America has made to the science of geology. As is well known it is the product of the labors of four distinguished petrographers—Professor Iddings, Professor Pirsson, Dr. Whitman Cross and Dr. H. S. Washington—and is based on the chemical composition of rocks rather than on their mineralogical character which formed the basis for the various older classifications.

In the earlier years of geological science but little attention was paid to the chemical composition of rocks, except in a very general way. Later when the chemical analysis of rocks came to be more common, the analyses were carried out in a very careless way since the rocks were considered to be merely aggregations of certain minerals the relative proportions of which might vary more or less, and, consequently, the chemical composition of the whole would be represented with sufficient accuracy even although an error of a per cent. or two in any one or other of the chemical constituents might be made. Now, however, the study of these igneous rocks is regarded as a study of silicate solutions and their equilibria and the subject has thus become a special branch of physical chemistry. Such being the case the accurate chemical analysis of igneous rocks is recognized to be of the greatest importance, and the correct understanding of the composition of these rocks is now seen to have a very far-reaching and important bearing on some of the most fundamental problems of the science.

As the importance of the chemical composition of rocks became increasingly recognized, attempts were made to collect and correlate all published analyses. The most notable of these was that of Justus Roth whose "Tabellen" of rock analyses were published by intervals between 1869 and 1884, and the more recent collection of A. Osann.

The present work by Dr. Henry S. Washington of the Carnegie Institution, Washington, goes far beyond these. Every serial whether published by a Survey, Society, or other organization, which might conceivably contain petrographic material, has been examined volume by volume, the examination embracing publications from the year 1883 to 1915. As all the analyses of importance published before 1883 had already been collected by Roth and are embraced in the present list—and as Dr. Washington has spared neither time nor effort to include in his paper all analytical material which is worthy of consideration—the present collection of analyses may be said to be complete, perfect and final. To use a colloquial expression the volume under review is "the limit."

The total number of analyses tabulated by Dr. Washington amounts to no less than 8,602, and it is significant of the increased interest taken in rock analysis in recent years to note that in the thirteen years from 1901 to 1913 inclusive, nearly twice as many analyses were published as during the sixteen preceding years between 1884 and 1900. This accounts

for the great increase in size of the present volume as compared with that of Professional Paper 99 which appeared from the pen of Dr. Washington in 1903, and which contained the analyses published up to that date.

Not only has the number of analyses published in recent years increased but the quality of the analyses has improved greatly—this may be seen if the more recent analyses are critically examined by the standards set forth by Dr. Washington, and it is especially noticeable that the quality of the analyses published in the United States, Great Britain, Canada, Australia and France, is now excellent, while the German analyses show a dead level of mediocrity.

This improvement is to be attributed in no small measure to the influence of Dr. Washington himself, since in his papers he has continually pointed out and insisted upon the necessity for greater care and thoroughness in rock analysis. In Dr. Washington's book on Mineral Analysis, improved methods especially adapted to the analysis of rocks have been described and explained. It may be mentioned in this connection that within the last few months his remarkable skill as an analyst of this class of materials, has been put to very practical account in connection with the striking investigations which have been carried to such a brilliant conclusion by the staff of the Geophysical Laboratory at Washington, in the manufacture of optical glasses required for the use of the United States Army and Navy. All of these glasses before the war were imported, for the most part from Germany, but now as a result of these researches they can be, and are being, made in sufficient quantity for the requirements of the service, under the direction of these gentlemen, in certain factories in the United States, a new industry having thus been established in this country.

The analyses assembled in this great collection are arranged in their proper order, according to the position of their "norms" in the Quantitative Classification. In each case not only is the analysis itself reproduced, but the "norm" is also given (the "norms" of the whole 8,602 rocks having been re-calculated and verified by Dr. Washington), as well as the locality, analyst, literature reference, and the name by which the rock is described by the author.

The analyses are arranged in four parts. Part I. embraces the "Superior Analyses of Fresh Rocks" and makes up the greater part of the volume. This is followed by Part II., which includes the "Superior Analyses which are Incomplete through the Non-determination of Some One or More Constituents." Part III. sets forth the "Superior Analyses of Weathered or Altered Rocks and Tuffs," while in Part IV. are gathered "Inferior Analyses" embracing those which are poor or bad.

The only errors to which attention is called are on p. 720, where in the Jacupirangite of Brazil the silica content should be given as 38.38 per cent. instead of 58.38 per cent. and on p. 1197, line 2, left column, where the caption British Guiana is omitted.

An excellent description of the Quantitative Classification itself, a tabular presentation of the divisions of names of the Quantitative Classification, the method of the calculation of the norm, together with tables of the molecular numbers and of the percentages of the norm molecules, are presented in five short appendices. It would subserve a very useful purpose if these appendices were reprinted separately, since they could be used much more readily in the form of a pamphlet of 30 pages than as part of the present massive tome embracing 1,200 pages. The reviewer hopes that the authorities of the United States Geological Survey will view favorably the suggestion that these appendices be issued as a separate paper.

Geologists will look forward to the discussion of "The Distribution of Magmas" and "The Average Rock" which are to be made the subjects of separate papers by the author, to appear later.

The excellent indexing of the volume and the high character of the press work are worthy of especial mention.

It is a volume which must find a place on the shelves of every petrographical laboratory in the world.

A lighter touch is given to this somewhat weighty subject—a connecting link with more transcendent things—by the text which appears in the upper corner of the page of preface. This is taken from Deuteronomy XXXII. 31, and reads as follows:—

For their rock is not as our rock, even our enemies themselves being the judges.

Certainly if the opponents of the Quantitative Classification have visited upon them the fate set forth as awaiting their representatives in the context of this passage from the Song of Moses, the Quantitative Classification of igneous rocks will be firmly established for all generations.

Frank D. Adams
McGill University,

A REVIEW OF SOME PAPERS ON FOSSIL MAN AT VERO, FLORIDA

In the number of the *American Anthropologist* for the first quarter of 1918 the writer is publishing a paper which deals with the discovery of Pleistocene man in North America. In that paper notice is taken of the literature which had appeared up to the time of writing it on the finding of human remains at Vero, Florida. Since then other articles on the subject have appeared, and I feel constrained to review briefly some of them. One of these papers is the official account of Dr. Hrdlička.[1] The gist of this account is found in these words:

The only satisfactory explanation of the conditions can be found in the assumption that the remains are those of intentional burials.

Naturally, this means satisfactory to the writer of the report; for six other men have furnished explanations on the same subject, each apparently satisfactory to its author, and all differing much from that of Dr. Hrdlička. At least three of those six men are experts in the solution of geological problems, but not one of the six sustains Dr. Hrdlička in his theory of intentional burial. Meanwhile he hardly attempts to remove the difficulties which beset his assumption. His method may be defined as the easy one of solution by fiat.

Three papers on the same subject appear in the *Journal of Geology* for October–November, 1917. They are the outcome of a week's collaboration and consultation at Vero on the part of Drs. E. H. Sellards, R. T. Chamberlin, and E. W. Berry. No comment is here made on Sellards's paper; for, so far as Sellards has expressed himself, the present writer is in accord with his views.

Dr. Berry's paper deals especially with the fossil plants found in the muck bed; but he discusses other important matters. He concludes that the muck deposit and, of course, the stratum of sand beneath it, belong undoubtedly to the Pleistocene; that the human remains were not buried intentionally; and that man lived there contemporaneously with the extinct vertebrates. He generously excuses Dr. Chamberlin's theory of the in-wash of the fossil bones and Dr. Hrdlička's theory of intentional burial on the ground that the age of the extinct vertebrate fauna had been overestimated. It is to be regretted if these experienced men were constrained to resort to desperate measures in order to save their anthropological theory.

It seems to the writer that Berry assumes to be true too many debatable matters. He says that the shell marl which underlies the other beds at Vero is late Pleistocene in age; and he bases this statement on the asserted fact that its species all now exist in near-by waters. Mansfield's list of mollusks[2] does not exactly support this statement. There are more than a dozen species about which there is doubt of one kind or another. Furthermore, if the molluscan fauna were not essentially that of Recent seas the beds would have to be assigned to the Tertiary.

Again, Berry takes it for granted that the lowest and youngest terrace, the Pensacola, is of late Pleistocene age; but this view lacks confirmation. This terrace is supposed to continue northward into the Talbot of Maryland and thence into the Cape May of New Jersey. The present writer is not inclined to question the conclusion of Salisbury and Knapp that the Cape May was coincident with the Wis-

1 Rep. Sec. Smithson. Inst. for 1917, p. 10.

2 Ninth Ann. Rep. Fla. Geol. Surv., p. 78.

consin; nor that the Talbot represents about the same period of time. Both of these formations are singularly destitute of vertebrate fossils. On the other hand, the lowest terrace in Florida, Georgia, and the Carolinas is filled with remains of extinct vertebrates down to salt water. At Wilmington, N. C., the great sloth *Megatherium* and horses are found. The latter occur all along the coast of North Carolina, along the Potomac, and on the west shore of Chesapeake bay. The line of horse-bearing localities is then taken up at Swedesboro, N. J., is continued past Philadelphia, and ends at the Navesink Hills. From the Potomac to Raritan bay it keeps far away from the Atlantic coast. In the Fish House clays, opposite Philadelphia, considerable horse remains have been found. By the New Jersey geologist these clays are regarded as belonging to the Pensauken formation; and this is referred to the early Pleistocene. The vertebrate fossils appear, therefore, to connect the lowest terrace of the south Atlantic states with the Pensauken, rather than with the Wisconsin. Berry's admission that the Vero deposits may be as old as the Peorian shows that he does not believe that any connection with the Wisconsin drift has been established.

The writer contends likewise that the Pensacola terrace has not yet been geologically correlated in the Mississippi Valley with any definite glacial stage.

Inasmuch as Berry grants that the Pensacola terrace may be as old as the Peorian interglacial stage he and I need have no quarrel about the age of the Vero muck bed. He may perhaps yet come to acknowledge that it may be as old as the Sangamon.

As regards Dr. Chamberlin's paper it may be stated that he has decided to abandon his theory of the secondary inclusion of the vertebrate fossils—"unless all other explanations fail." He asserts (p. 667) that the dates of the appearance of man and of the disappearance of the extinct animals were among the very points brought into question and could not themselves be used as decisive criteria. With that part of this statement which concerns man I agree; but with that which regards the vertebrates I dissent. The time when those vertebrates lived and when they disappeared is to be determined by their relation to the deposits in which they have been found in a thousand or more other places in our country; and it is legitimate to apply the knowledge gained therefrom to the situation at Vero. Chamberlin seems to respect rather lightly the vertebrate fossils, for he believes that the time relations of the deposits were quite well indicated by the physical criteria, irrespective of their fossil contents. He believes, with Berry, that the marine marl bed and with it the Pensacola terrace is late Pleistocene in age. The writer takes this occasion to say that if the geologists can prove that proposition it will at once end the dispute about the time of the disappearance of the fauna represented at Vero; and vertebrate paleontology will become once more indebted to geology. Pending that proof I shall maintain, on the evidence of the vertebrate fossils, that that terrace belongs to the early third of the Pleistocene.

Dr. Chamberlin's faith in the value of fossils seems to be somewhat livelier when, in order to determine the age of the human relics at Vero, he cites the age of European pottery and men's bones; but what connection has been established between the use of pottery in Europe and its use in America?

It is not a little amusing to observe that the camels and horses and their fellows, which under the designation of a "Pliocene fauna" were used at Table Mountain to combat the existence of early man, are now, at the other, far distant, end of the line, mustered in as a "mid-Recent fauna" and called into service to continue the same war.

Oliver P. Hay
Carnegie Institution of Washington

SPECIAL ARTICLES

THE ANIMAL CENSUS OF TWO CITY LOTS

Aside from articles by McAtee, Banks and Herbert Osborn,[1] very little attention has

1 McAtee, W. L., "Census of four square feet," Science, Vol. 26, pp. 447-49, 1907; Banks, N., "A 'census of four square feet,'" Science, Vol.

TABLE I

Animal Population of Areas of .518 Sq. Ft.

Date	Slugs	Earthworms	Millipedes	Centipedes	Sowbugs	Mites	Spiders	Thysanura	Orthoptera	Homoptera	Hemiptera	Lepidoptera	Diptera	Hymenoptera	Coleoptera	Miscellaneous	Total Insects	Total Animals	Lot
September 25......		1										1	1	49	3		54	55	Green
September 26......						2	3			6			3	2	2		13	18	Green
September 26......		2				1	3				1	1		2	3		7	13	Green
October 2........					2		6			8	1			9	4		22	30	Green
October 2........					4	2	4			9		3		2	4		18	28	Green
October 5........		26	3		10		2			2		1			1		14	45	John
October 5........	1	19	3		12		3			7					1	2*	10	48	John
October 5........		7			6		1			1				2	3		6	20	Green
October 6........			1		5		2			1	1	3		2	2		9	17	Green
October 6........		8			1		1			2	7		1	3	5		18	28	Green
October 11.......					4	1	3			6				3	9	58*	76	84	Green
October 11.......	2	2	1		7		8	1		8	2			4	8		23	43	Green
October 11.......			3							53	3			7	5		68	71	John
October 13.......		6										1		1	1		3	9	Green
October 25.......	1	3			11		1		38*		2				4		44	60	Green
October 25.......		2	2		1		1				1	1		1	2		5	11	John
October 25.......	2	2			8		12	1		2	2	1		1	4		11	35	Green
October 27.......		3			3		2			2		2			4		8	16	Green
October 27.......		8	3	1	3	1	5			10	1	9			11		31	52	John
October 31.......	1	1				3	2						1	1	37		39	46	John
October 31.......		4	1		8		1			1		10			6	1	18	32	Green
November 1.......		11					2				1			1	2		4	17	Green
November 1.......		7			2	1	5								2		2	17	John
November 3.......		3					3		91*	2		4			4		101	107	Green
November 3.......		6			8		1			44†	3			9	5		61	76	Green
November 3.......		1					38											39	Green
November 3.......		10		1	2		1			1		1		12	8		22	36	Green
November 6.......		17						1		1		3		1	12		18	35	Green
November 6.......		4										1			1		2	6	Green
November 6.......		4	3		1	1	5			1	1				4		6	20	John
November 9.......		4					2			49†	4			1	11	7	72	78	John
November 10......		5			2		5							5	2		7	19	Green
November 10......		5		2	23	1	9	15	12*	49†	4	1		1	16		98	138	Green
November 17......							5			1		4			2		12	12	John
November 27......		3		1	10		4	2		18					7		27	45	Green
November 27......		1		1			1				1				5		6	9	John
November 29......		3					6			2	2	4			17		25	34	Green
December 1.......		8			3	1	3	4		3	1	2			24		34	49	Green
December 1.......		3					10	1			3	2			3		9	22	John
December 6.......		4					4	12		17		3	4		2		38	46	Green
January 7.........		(Ground frozen)				1	2				2				2		4	7	Green
January 7.........		(Ground frozen)					2				1		4		8		13	15	John
March 22..........		6	2		1		5				2				4		6	20	Green
March 22..........			1						83*						8		91	92	John
March 30..........		12			21		2				2	2			3		7	42	Green
March 30..........		4	1		1	3			107*						2		109	118	John
April 10..........	1	43			1		1			158*					5	2	165	211	Green
April 10..........		9	4	5	15	7						1		5	9		15	55	John
April 11..........		19			22		2			87*	1	1	2		5		96	139	Green
April 11..........		10					2					3			3		6	18	John
April 12..........		22			5										4		4	31	Green
April 12..........		3	4		4	5	1		112*	4		2	1	96	1		216	233	John
April 17..........		13			5		1							2	6		8	27	Green
April 17..........		4	8	1	38	2	2	1			1	6		1	19		27	83	John

TABLE I (*continued*)

Date	Slugs	Earthworms	Millipedes	Centipedes	Sowbugs	Mites	Spiders	Thysanura	Orthoptera	Homoptera	Hemiptera	Lepidoptera	Diptera	Hymenoptera	Coleoptera	Miscellaneous	Total Insects	Total Animals	Lot
April 18...........		10		2	6	1	2	2		1	1			1	7		12	33	Green
April 18...........		21	3	3	23	4	4	3				2		6	6		17	75	John
April 23...........		15			5	1	1					3	2	4	1		10	32	Green
April 23...........		6	2		3										2		2	13	John
April 26...........		7			6		3	5			1			2	3		11	27	Green
April 26...........		11	1	3	31	2	2	1			1				8		10	60	John
May 10...........		11			5	1	1					1			1	3	2	23	Green
May 10...........		8			16	1	4	3			1	3	1	1	5		14	43	John
May 14...........		19	1	4	17		1	4						1	5		10	52	Green
May 14...........		8	2	1	42	2	5	4			2	2			3		11	71	John
May 15...........		7		2	8			3			1			9	2		12	32	Green
May 15...........		14	5	1	11		4				2	2			1		5	40	John
May 17...........		4	3	1	14	2	1			2		1		11			14	39	Green
May 17...........		2	6		2		1			1	1	3		20	1		26	37	John
May 18...........				1	15	1	2		3*		2	3		7	8		23	42	Green
May 18...........					4		3			1	1	1		42	2		47	54	John

* Indicates eggs. † Indicates partly eggs.

been given to the total animal population of definitely measured areas of land. At the suggestion, and with the aid and assistance, of Dr. V. E. Shelford, of the University of Illinois, a study was made of the animal population of two vacant lots, a block apart, in Champaign, Illinois, over a period from September, 1916, to May, 1917. The lots were on John and Green Streets, adjoining the Illinois Central Railroad. They had not been burned over for at least a year, and despite the encroachments of débris from the railroad and nearby houses, were essentially wild, being covered with grass, sweet clover, dandelions, burdocks and other weeds, while the Green Street lot had a thicket of young honey locusts on one side, and that on John Street had a brook bordered by osage orange and willows running along one side.

The apparatus used was very simple, consisting of a tin pail with the handle and bail removed, and a screw top, an inch in diameter, soldered into the bottom, through which the anesthetizing agent could be introduced. The sharp edges of the pail, where the bail had been cut away, would sink into soft earth, and with the aid of a big knife, vegetation and hard earth could be cut through, so that the animal population of that small area would be imprisoned in the inverted pail. A considerable amount of chloroform or ether was added through the screw top, and after clearing away the surrounding vegetation and débris, sufficient time would have elapsed so that all the active animals were anesthetized and the pail could be taken up without fear that any of them would escape. The vegetation within the circle was picked to pieces and shaken over newspapers, weed stems split up, the surface of the earth left bare was carefully examined and finally all the earth to a depth of six inches was dug up and sifted over newspapers, so that all animals large enough to be visible to the naked eye would be sorted out. The surface area covered by the pail was .518 sq. ft., which, multiplied by 84,092, gives the population per acre. Two examinations (one for each lot) were made daily when time was available, or the ground not too wet and sticky or frozen. The results are given in the table.

26, p. 637, 1907; Osborn, H., "Leaf-hoppers of Maine," Maine Agr. Expt. Sta. Bull., No. 238, pp. 81–160, 1915.

The area enclosed by the pail (.518 sq. ft.) is so small that there will necessarily be a wide

TABLE II

Average Animal Population for Twenty-day Periods

Period	Earthworms	Millipedes	Centipedes	Sowbugs	Mites	Spiders	Thysanura	Orthoptera	Homoptera	Hemiptera	Lepidoptera	Diptera	Hymenoptera	Coleoptera	Total Insects	Total Except Insects	Total Animals
September–October...	4.4	.8		3.6	.5	2.6			7.4	1.1	.7	.3	6.1	3.6	24	12	36
October–November...	4.7	.5		3.5	.4	5.7		10.	4.8	.8	2.2		2.	7.6	26	16	42
November..........	6.1	.4	.3	3.7	.3	3.7	2.3	1.7	14.4	1.2	1.2		1.1	7.	31	13	44
November–December..	3.7		.3	2.3	.2	4.3	3.2		6.7	1.2	1.8	.7		9.7	23	11	34
Winter:																	
March–April.........	12.8	1.2	.5	7.1	.5	1.3		30.2	24.9	.5	.9	.3	10.1	4.4	72	24	96
April................	10.9	1.7	1.1	12.1	1.2	1.9	1.5		.1	.5	1.4	.2	2.2	6.5	12	32	44
May.................	7.3	1.7	1.	13.4	.7	2.2	1.4	.3	.4	1.	1.6	.1	9.1	2.8	16	26	43
Average.............	7.1	.9	.5	6.5	.7	3.1	1.2	6.3	8.4	.9	1.4	.2	4.4	6.9	29	19	48

TABLE III

Revised Animal Population

Period	Total Orthoptera	Orthoptera (One Egg-cluster Equals One Individual)	Total Homoptera	Homoptera (One Egg-cluster Equals One Individual)	Revised Total Animals	Revised Total Insects	Revised Total Except Insects	Animals per Acre	Insects per Acre
September–October...			7.4	7.4	33	21	12	2,665,036	1,756,932
October–November....	10	.1	4.8	3.	30	15	15	2,422,760	1,261,380
November..........	1.7	.1	14.4	3.	31	17	14	2,506,852	1,429,564
November–December .			6.7	1.5	30	18	12	2,422,760	1,513,656
Winter:									
March–April.........	30.2	.3	24.9	1.	42	1	23	3,531,864	1,597,748
April................			.1	.1	44	2196	32	3,700,048	1,009,104
May.................	.3	.1	.4	.4	43		27	3,605,956	1,345,472

variation in abundance in all orders of animals in any two examinations, and it is only by averaging results for twenty-day periods that some idea can be gained of seasonal variation.

The great unevenness in the Orthoptera and Homoptera columns is because each individual grasshopper or mealybug egg is counted as an individual. The result is to greatly increase the apparent total animal population in the fall and early spring. But when each cluster of eggs is counted as one individual, the Orthoptera become negligible and the Homoptera decrease in numbers from early fall, the resulting total animal population showing a very striking uniformity throughout each season.

The one third increase in population in the spring over that in the autumn is due, not to insects, but almost entirely to earthworms and sowbugs—the earthworms being most abundant early in the spring when the ground is moist, and going deeper than six inches as it later dries out, but the sowbugs become most abundant in May. Variations in the Hymenoptera column are due to occasional accidental selection for examination of a plot containing a nest, or near a nest of ants, but variations in the numbers of beetles, of which many species in greatly varying abundance were found, can not be assigned to any one cause. Considerable numbers of empty puparia were found, quite out of proportion to the small number of live Diptera. Thysanura were very abundant when weather conditions were just right, but Lepidoptera (mostly cutworms) and Hemiptera showed quite uniform abundance. The data as a whole show the preponderating abundance of earthworms, sowbugs, beetles, spiders and ants in this particular habitat.

George N. Wolcott

1539 Sunset Ave.,
Utica, N. Y.